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DEFENSE MAPPING AGENCY TOPOGRAPHIC CENTER

TECHNICAL REPORT No. DMATC 76-2

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CONVERSION OF BLACK-AND-WHITE PHOTOGRAPHY TO FOUR-COLOR LITHOGRAPHY

Hale M. Luig

Defense Mapping Agency Topographic Center

MAY 1976

DEFENSE MAPPING AGENCY
TOPOGRAPHIC CENTER
Washington, D. C. 20315

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Color Separation	Image Tone Enhancement	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this study was to determine the feasibility of a new technique, *colorization*, for converting black-and-white photography to naturalistic color for orthophotographics. The cartographic reproduction process is based on a simulated color separation of the black-and-white imagery into the four components required for process printing, i.e., yellow, magenta, cyan, and black.

This initial test was confined to a 7½-by 11-inch black-and-white aerial photo from which four positive separations were colorized. Minimal indicia were added by hand. Thus, in combination, a

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20. ABSTRACT

pictorially naturalistic graphic, with minimal cartographic treatment, was rendered in full color for visual inspection. An equivalent full color proof on an opaque white substrate was produced from subsequent negatives in conjunction with a dropout roads mask.

The technique appears to offer the combined advantages of black-and-white photography for contrast and color imagery for interpretation, while surpassing both additive color systems and complex subtractive methods in economic prudence.

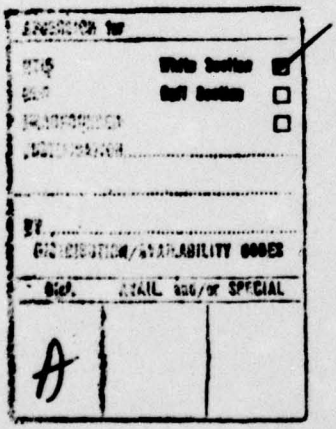
PREFACE

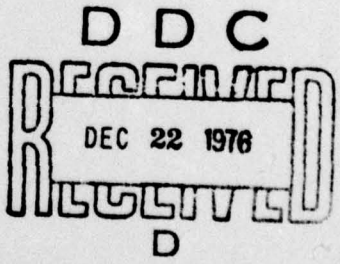
This investigation was conducted under the authority of Engineering Applications Project Assignment No. 148, I.D. No. DA410027, entitled "Conversion of Black-and-White Photography to Four-Color Lithography," approved 11 August 1970.

Test and evaluation were conducted by Mrs. Hale M. Luig, Project Engineer, under the general supervision of Mr. Joe W. Nair, Acting Chief, Applications Engineering Branch, Systems and Materiel Division, Department of Cartography. Consultation was provided by Messrs. John S. Odell, and Earle M. Knibiehly, Cognizant Staff Engineers, Directorate of Plans, Requirements, and Technology.

Final test results and evaluation on one phase of this project were completed in May 1971. This report covers work performed under the aegis of the U.S. Army Topographic Command which was incorporated into the Defense Mapping Agency in 1972 as the Defense Mapping Agency Topographic Center (DMATC).

The author was issued U.S. Patent No. 3,595,651 in 1971 for the process described in this report. The technique has not been adopted for production by DMATC. A subsequent report will be published.





CONVERSION OF BLACK-AND-WHITE PHOTOGRAPHY TO FOUR-COLOR LITHOGRAPHY

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SECTION I. INTRODUCTION

1. PURPOSE. The purpose of this study was to determine the feasibility of a new technique, *colorization,* for converting black-and-white photography to naturalistic color for orthophotographics. The cartographic reproduction process is based on a simulated color separation of the black-and-white imagery into the four components required for process printing, i.e., yellow, magenta, cyan, and black.

2. SCOPE. This test was confined to achieving a pictorially naturalistic graphic with minimal cartographic treatment; overall size was limited to 7½ by 11 inches for:

- Qualitative comparison with existent orthophotomaps,
- Determination of features to be depicted cartographically, and
- Providing a guide for a more comprehensive, in-house test at full sheet size. (22 in by 30 in).

3. BACKGROUND. The accelerating trend toward the use of the orthophotograph as a map base emphasizes the need for a better quality orthophotomap produced at a faster rate and at a reduced cost.

4. PREVIOUS INVESTIGATION. Early experimentation resulted in the pictomap currently in use.[1,2] The U.S. Geological Survey was actively engaged in promotion of the orthophotograph as a map base and, with their development of the Orthophotoscope, considerable improvement was made in the appearance of the printed map sheet, but no appreciable reduction in cost was realized.[3,4,5] The U.S. Naval Oceanographic Office experiments in four-color process printing resulted in implementation of a modified version of the pictomap while partial success was achieved in a continuous-tone printing experiment using extraterrestrial

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[1] HAYES, T.J., MG, USA. "A New Map for Vietnam–The Pictomap." *The Military Engineer.* July-August 1966: No. 384, pp 255-256.

[2] VAN ATTA, W.H., COL, USA. "Mapping of Southeast Asia." Presented to the 27th Annual Meeting of the American Congress on Surveying and Mapping, Washington, D.C. March 1967.

[3] PUMPELLY, J.W. "Color Separation and Printing Techniques for Pictomaps." *ACSM Journal.* June 1967: pp 277-280.

[4] LOVING, H.B. "New Mapping Techniques and Trends in the U.S. Geological Survey." *Papers from the 1968 National Fall Convention, American Congress on Surveying and Mapping.* Washington, D.C.: ACSM. September 1968: pp 194-197.

[5] PILONERO, J.T. "Research on Orthophotomaps for Metropolitan Areas." *Papers from the 35th Annual Meeting, American Society of Photogrammetry.* Falls Church, Va.: ASP. March 1969.

photography.[6] Later, the U.S. Army Engineer Topographic Laboratories (USAETL) produced two experimental orthophotomaps by three-color process lithography.

SECTION II. INVESTIGATION

5. APPROACH. This investigation was to be performed in two separate but related phases for:

- An evaluation of the color separation, by *colorization,* of the halftone positives for four-color process printing, and
- An evaluation of one composite positive of map copy, *colorized,* to be electronically scanned for color separations for four-color process printing.

Only the first phase is covered by this report; the second phase was not performed.

6. PHOTOGRAPHIC STEPS. The production of films for *colorization* began with the conventional continuous-tone negative, from which a continuous-tone positive of reduced contrast was contacted. This second-generation positive received minimal retouching to insure no highlights dropping out in the screening. Four third-generation positives were obtained by equal-time contact exposures through a 150-line Caprock* vignetted mezzotint screen (negative) on lithographic film. An aborted chemical reversal development followed, resulting in an extremely faint, gelatin relief image on a cleared film base. The fifth exposure, a D-max flash line shot on high contrast lith-type film, for image tone enhancement (ITE), received conventional development. The total four steps required from inception to ready-for-reproduction negatives are diagrammed in figure 1. Testing was restricted to one set of four chemical reversal positives (RevPos) due to phasing out of this chemistry in the trend toward autopositive duplicating products.

7. COLORIZATION. Three of the faint, residual images were selectively *colorized* with common food-coloring dyes, undiluted, to equate the process inks—yellow, magenta, and cyan—used in four-color process printing; the fourth RevPos was *colorized* with Martin's transparent black watercolor, and then the density was reduced by hand-etching, to provide a "ghost" image. All *colorization* was achieved by a rub-on technique; no masking was required as watersoluble dyes will not adhere to the cleared film base. The only correction necessary was removal of dye from the open water area on the yellow and magenta plates. This was accomplished by applying ammonia to the dyed open water area, removing its residue with water, and blotting.

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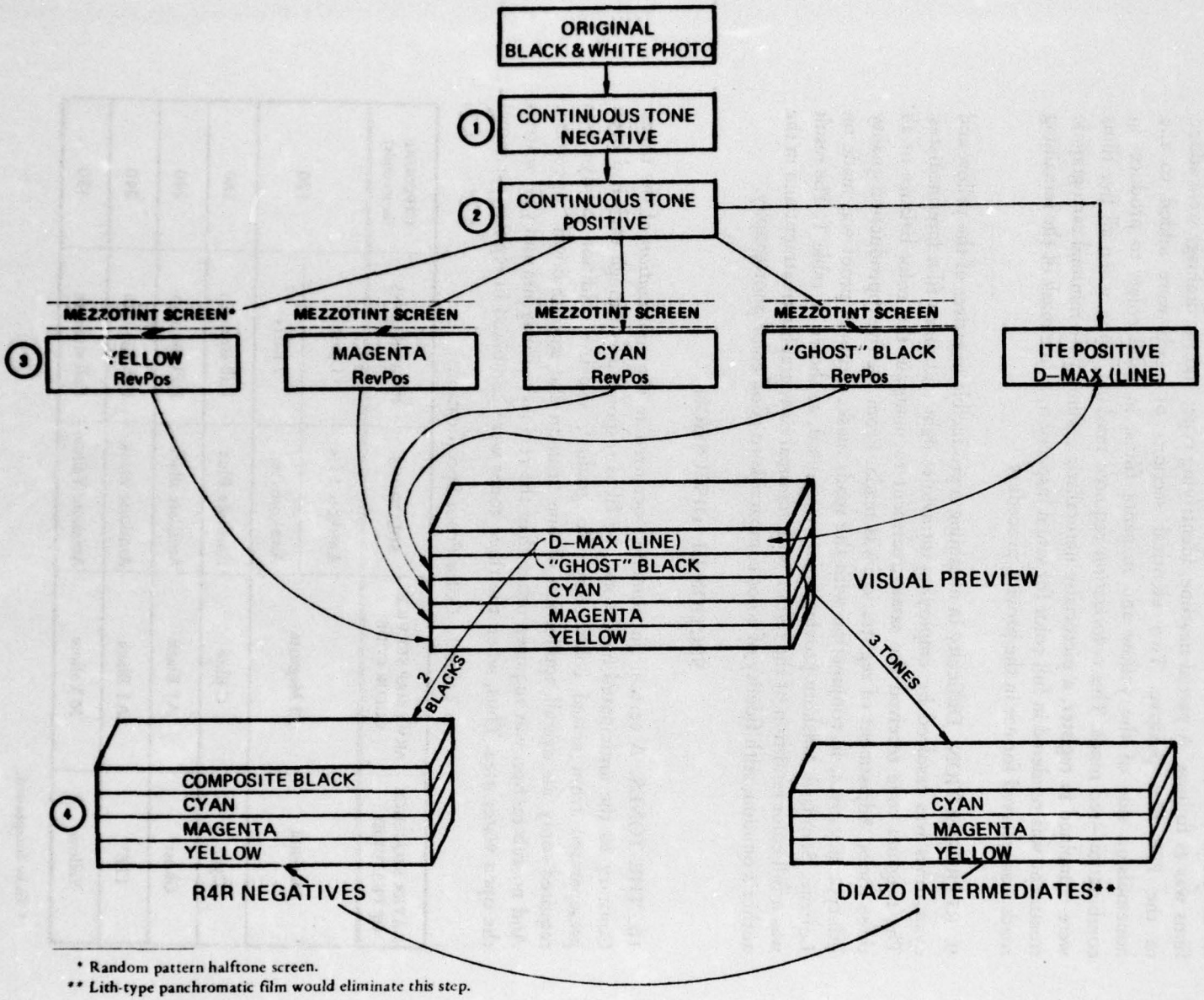
[6] Naval Oceanographic Office Informal Report No. 68–73. "Three Different Techniques of Color Separation Applied to Charting and Printing." Washington, D.C.: U.S. Naval Oceanographic Office. October 1968.

* Any mention herein of a commercial product does not constitute endorsement by the U.S. Government.



* Random pattern halftone screen.
** Lith-type panchromatic film would eliminate this step.

Figure 1. Photographic steps in the production of films for *colorization*.

8. **CARTOGRAPHIC TREATMENT.** The minimal cartographic treatment of these films was as follows. A partial neatline, identifying type, and the drainage were added to the ITE film positive. Two identical sections of roads were added to the nonemulsion side of the yellow and magenta films, in solid color, to produce—in combination—red roads. This *colorization* required masking. Thus, when all five films were combined in register, a pictorially naturalistic graphic with minimal cartographic treatment was rendered in full color for visual inspection. A line mask of the remaining roads was reserved for use in the proving procedure.

9. **REPRODUCTION.** Difficulty in obtaining reproducible negatives of the yellow and cyan tones was resolved by employing ultraviolet light and diazo film intermediates. The magenta tone received the same treatment to maintain the color balance of all three tones. Adjustment of registration was made. From the five reproduction-quality lith-type negatives, in conjunction with the roads mask, a rub-on proof was made on Loftrite. Standard Amskote proving colors were used, as shown in table 1. The result was a full-color rendition of the terrain with minimal cartographic treatment and in the author's opinion, with fidelity of color comparable to good color photography.

SECTION III. DISCUSSION

10. **THE TONES.** A certain phenomenon occurred in the *colorization* of the tones. Contrary to the anticipated handwork, the films responded as though each had been preseparated from actual color copy. No gradual, selective addition of dye was required—only an overall application of one "rub-on and smooth-down" operation. And no subtraction was required other than the removal of magenta and yellow from the open water area. Thus, when the three tones were combined in register for visual

Table 1. Color Proof Specifications

LAYER SEQUENCE OF FEATURES	ARMY MAP SERVICE COLOR CODE	SOLUTIONS	PROPORTIONS	EXPOSURE (in seconds)
Magenta	J3 Magenta	Amskote Blue	1 part	120
		Amskote Red	7 parts	
Cyan	C Blue	Amskote Blue	Full strength	180
Ghost*	A1 Black	Amskote Black	Full strength	240
ITE*	A1 Black	Amskote Black	Full strength	240
Yellow	M Yellow	Amskote Yellow	Full strength	480

* To be composited.

inspection, a natural color replica of the terrain, exclusive of manmade features, appeared. Adding the "ghost" black to the three tones increased the definition of detail. Topping this with the ITE gave the total visual a dynamic punch much like three-dimensional perspective. In addition to being color-separated copy, this variegated visual illustrates an effective and economical way to produce color vugraphs for projection from one original in lieu of multidiazo foils which require an individual drawing for each color.

11. THE FILMS. Kodalith type 3 ortho film, size .178 mm (.007 in) was used for all the RevPos and the line-shot ITE. DuPont Cronar ortho film proved unsuitable due probably to its synthetic-type emulsion. DuPont Cronar commercial–S, size .178 mm (.007 in) was most satisfactory for the continuous-tone films. Etching of the black-colorized RevPos was accomplished with a 50 percent solution of tincture of iodine with water. This "ghost" black could be achieved easier and cheaper, however, by conventional development and exposure/development controls. Holding the color balance of the tones in making R4R negatives cannot be accomplished on Kodalith film by identical exposure and development; lith-type panchromatic film is the logical answer here. Filters and/or ultraviolet light are resourceful allies also. Attempts to adhere to the time frame of this project induced employment of in-house diazo films for intermediates. Despite the alleged inferiority of these foils, the re-registration required, and the apparent loss of detail, the immediate need was served, and R4R Kodalith negatives were made with no further difficulty. Subsequent investigation of stable-base diazo films indicates that an anhydrous, ammonia-developed diazo emulsion on a .127 mm (.005 in) polyester base is an excellent duplicating material and may be used advantageously also for lithographic negatives of single and multiple exposures. Dot size can be faithfully duplicated and dimensional stability is excellent. Employment of this nonsilver stable-base product could alleviate our critical silver-shortage problem.

12. THE SCREEN. A random pattern, as effected in the photomechanical reproduction of the pictomap, is highly effective for depicting terrain. Introduction of a mezzotint screen offers a 100 percent production-oriented method of random screening continuous-tone copy. Available on the market are 75-, 150-, and 225-line mezzotint screens in sheet sizes up to 27 by 35 inches for a flat tint and 23 by 29 inches for a vignetted screen. The 150-line mezzotint screen used in making this test surpassed all expectations. It was easy to use because it required no angling and eliminated any possibility of moiré, but the screen pattern in the four-color juxtaposition was so fine, in both the visual and the proof, that is suggested being a continuous tone. This observation was more surprising in the proof inasmuch as the diazo intermediates showed considerable loss of detail. The success of this Caprock mezzotint screen was due undoubtedly, at least in part, to its being 150-line and vignetted. The four preangled, 133-line elliptical dot halftone screens, requisitioned for

the initial *colorization* test, were not utilized due to curtailment of accommodations for making the chemical reversal films on which this project depended.

13. CARTOGRAPHIC TREATMENT. It has been shown, by the addition of some cartographic features to this test, that *colorization* could absorb some of the cartographic requirements and still be within the confines of four-color process printing. It has also been shown that the black ITE serves a dual purpose by acting as the standard positive overlay for black indicia while enhancing the photo-base imagery. The drainage was arbitrarily added to the ITE in natural flow lines; this does not constitute a determined specification although the idea seems worth entertaining if this test product is to provide a guide for a more comprehensive, in-house test. Priority should be given to the evaluation of this test product and a determination of the features to be depicted cartographically on a full-size test sheet should be made. This should be an objective evaluation tempered by futuristic trends; it should not be based on a sole predecessor, the pictomap. There is no correlation between the pictomap's false color rendering by three reproducibles (requiring 12 photographic steps, exclusive of cartographic annotation) and this product's naturalistic four-color treatment requiring 4 photographic steps and including some cartographic annotation.

14. REPRODUCTION. All indications favor the feasibility of printing this product as a production item. Maintaining registration on the press is a critical factor; this is an inherent part of four-color process printing. However, this requirement has been lessened considerably by use of the mezzotint screen instead of conventional, angled halftones. No more than the usual amount of difficulty encountered with the implementation of any new job is anticipated overall. Adjustment of inks for color match and establishment of color sequence in printing are expected; the exposure and sequence factors listed in table 1 for the color proving can serve as preliminary guidelines. Neither special features requiring compositing, nor a separate pressplate should pose a problem, nor should the screening of additional features. Only a question of resolving whether a conventional, angled halftone screen or a mezzotint or a special-effects screen is required. An objective limitation of specifications to five colors will permit one-run production on the five-color presses, thereby providing better registration control.

SECTION IV. CONCLUSION

15. This project has accomplished its basic objective by proving the feasibility of the *colorization* technique for converting black-and-white photography (figure 2) to naturalistic color (figure 3). It is predicted that future color reproduction from either black-and-white or color photography will be accomplished without scanning or current modes of separation, and that a system will evolve that depends solely on density readings and standardized automatic processing.

SECTION V. RECOMMENDATIONS

16. Preliminary cartographic and reproduction standards and specifications should be established for a full-size color orthophotomap test sheet to be produced by the *colorization* technique. This test product, tentatively designated as the *spectromap*, is required for a qualitative and cost comparison with the orthopictomap.

Figure 2. Sample black-and-white photograph.

SECTION VI. SELECTED BIBLIOGRAPHY

BOND, S. "True-Color Reproduction–Unattainable?" *Printing Magazine/National Lithographer.* September 1967: pp 62, 63, 98.

BONDURANT, A.J., Jr. "Color Orthophotographics." Presented to the National Fall Convention of the American Congress on Surveying and Mapping, Denver, Colorado. September 1970.

BYER, W. "Offset Litho Presswork: Four-Color Process Ink Sequence." *Graphic Arts Monthly.* January 1970: Vol. 42, No. 1, pp 102, 104.

CLARK, C. "Reproduction of Orthophotographics." Presented to the American Congress on Surveying and Mapping Orthophoto Workshop, Washington, D.C. January 1971.

"Color Reproduction." *Pocket Pal.* Tenth Edition. M. Bruno, ed. New York, N.Y.: International Paper Company. June 1970: pp 81–85.

"DENSTMAN, H. "Color Slides from Black and White Art." *Industrial Photography.* January 1970: Vol. 19, No. 1, pp 18–20, 69–72.

DEURWAARDER, J. "A Short Course on the Theory and Control of Color in Print." *Printing Magazine.* October 1969: pp 100A, 100D.

LUIG, H.M. "Film Color Transparency and Method of Manufacture." U.S. Patent 3,595,651. 1971.

"NAVOCEANO–A Report on Its Activities." *Modern Lithography.* March 1966: Vol. 34, No. 3, pp 26–29.

"Provisional Specifications for the Pictomap." *DMATC Technical Manual S–1,* Chapter 14, Section IV. Washington, D.C.: Defense Mapping Agency Topographic Center. February 1966.

ROSS, D.S. "Image Tone Enhancement." Presented to the 35th Annual Meeting of the American Society of Photogrammetry, Washington, D.C. March 1969.

SANT, A.J. "Procedures for Equivalent-Neutral-Density (END) Calibration of Color Densitometers Using a Digital Computer." *Photographic Science and Engineering.* September-October 1970: Vol. 14, No. 5, pp 356–362.

STOEPPELMAN, H.J. "Special Effects With Color." *Reproduction Methods.* January 1970: Vol. 10, No. 1, pp 30-31.

STOESSEL, O.C. "The Simulated Process Printing of Aeronautical Charts." Presented to the 28th Annual Meeting of the American Congress on Surveying and Mapping Convention, Washington, D.C. March 1968.

"TOPOCOM Produces Color Orthophotomap on Map Stock." *Topocomments.* Washington, D.C.: Defense Mapping Agency Topographic Center. 10 October 1969: Vol. 1, No. 16.

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